of the dark masses on the great northern belt. The spot is also liable to become very faint. I have carefully noted these variations, and though the observations are not sufficiently full to determine the period, if any, they show that the spot becomes faint almost to invisibility at intervals of about 56 days, and that increased brightness of the spot is accompanied with accelerated motion. I believe this particular object is a permanent feature on the planet, and that it lies far below the level of the dusky belts. Mr. Marth has determined from a discussion of the observations of 1880 and 1881 (to November) that the mean motion of the spot has been uniform, and this is important as a proof of its stability. My own numerous observations have led me to conclude that:—

1. It is self-luminous and light-emitting.

2. That it is a part of, or projection from, the actual surface of the planet.

3. That therefore it indicates the real rotation period of Jupiter, which is 9h. 50m. 6·6s. (= daily rate 878°·48), as deduced by Mr. Marth. The motion of the red spot shows a decided slackening, so that we cannot accept it as a reliable and invariable indication of the motion of the Jovian sphere with which probably it has no material connection.

These conclusions are supported by the fact that we cannot admit the idea of an object as permanent and conspicuous as the white spot, rushing on in advance of the already swift axial movement of the planet (as computed from the positions of the red spot) whereas we can more readily understand that atmospheric objects, such as the belts and red spot (which are forms of identical phenomena), would show a tendency to lag behind the rapid motion of the sphere. We must allow that there will be a failure of objects on the extreme outer envelopes of Jupiter, to keep pace with the tremendous velocity of objects on his real surface. The dusky belts, the red spot, and similar markings, are probably openings in the Jovian atmosphere, and the slackening motion of these objects is simply the indication that they are becoming more shallow than formerly, whence we may infer that the motion will continue to decrease until they are finally dissipated.

A comparison of my recent observations with those made by Gledhill and Welb in the years 1869-72, show that many of the features which they described and delineated (in the *Astronomical Register* and *Popular Science Review*) are still visible or have reappeared after an interval of obscuration. The great red spot may be the same object as Gledhill's ellipse of 1869-71. In many of the details visible then and now there is a remarkable similarity both in aspect and position, and the observers of Jupiter should further carefully investigate the physical appearance of the planet with a view to obtain more distinct evidence on the question of periodic variations. In this connection I may quote a remark by the late Mr. Lassell (*Monthly Notices*, vol. xxxiv. p. 310), where, in referring to round light spots he saw on Jupiter in March, 1850, and March, 1874, he says: "I believe the appearance of these spots is very rare, as I have not seen them for many years, and the general similarity of the aspect of the planet now [1874] and then [1850] suggests the idea that the various phases return in cycles, which I think more probable than that absolute secular changes occur in the heavenly bodies within the limit of time of any human records." W. F. DENNING

LITTLE ELECTROMOTORS

THE probability that within a few months almost every large town and city will be supplied with electricity on a large scale for the purpose of lighting, has brought into prominence the question of utilising the same supply for the purpose of producing power on a small scale for sundry domestic purposes. There are a number of objects for which machinery is employed, though on so small a scale that it would not be worth while to set up a steam-engine or gas-engine to drive it, to say nothing of the inconvenience of a steam- or gas-engine in a private house. To drive a sewing-machine, for example, or to work a light turning-lathe, requires a comparatively small power, and usually only for a limited time. It is natural then to think that when the power of electricity is available in the wires which supply electric light, such a power, especially as it is so simply and readily controlled, might be economically employed for such purposes.

But to drive machinery by electric currents necessitates the employment of the appropriate electric engine or "electromotor," which, as its name implies, is an engine which, by the expenditure of electrical energy, does mechanical work. Such engines have been known since 1831, when Prof. Henry first constructed a rotating engine driven by electromagnets. Ritchie, in 1833, independently constructed an electromagnetic apparatus for producing continuous rotation. Fig. 1, which we borrow from Prof. S. Thompson's "Lessons in Electricity and Magnetism," shows a modification of Ritchie's electromotor frequently found in collections of electrical apparatus. It consists simply of an electromagnet, C D, poised upon a

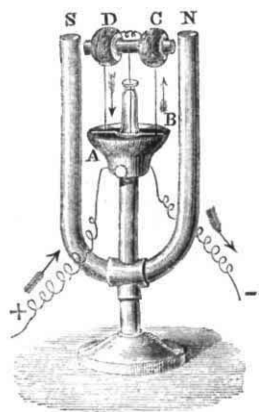

FIG. 1.

pivot between the poles, N S, of a steel horseshoe magnet, and fitted with an arrangement of mercury cups, A B, as a commutator, by means of which the current arriving through the wires is so directed through the coil as to produce motions, in one sense, only round the axis. The pole C of the electromagent is attracted round toward S until, just as it nears S the wire beneath C passes from one mercury-cup to the other, so reversing the current and causing C to be repelled from S and attracted to N.

To speak of the further developments of these machines in the hands of Jacobi, Sturgeon, Froment, and others, would be to traverse ground too wide for the scope of an article like this. Paccinotti's discovery of the ring-armature, which in 1869 he applied to the construction of an electromagnetic motor which was also capable of being used as a generator of currents, dropped strangely out of sight. And the subsequent discovery of M. Gramme that his generator would work as a motor was only the beginning of a new epoch in the history of electromotors. We know that all the magneto-electric and dynamo-electric machines used to generate continuous currents of electricity, whether of Gramme, Siemens, Brush, or Edison are *reversible*. If we drive them by mechanical power they yield electric currents, and if on the other hand we supply them with currents of electricity, they can run backwards and do work for us. Sawing and ploughing are now done every day by this means. We have Siemens' electric railway and tramway, and many other useful applications of the same principle, of which

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one of the newest and most interesting is Dr. Hopkinson's electric elevator or "lift."

But to come back to the application of power on the very small scale adapted for domestic purposes; several *small* motors exist, each of which can do excellent work. The earliest of these small modern motors is that of M. Marcel Deprez, invented about three years ago, and which consists (see Fig. 2) of a single Siemens armature, A B, of the old well-known type, placed longitudinally between the poles of a horse-shoe, or rather a U-

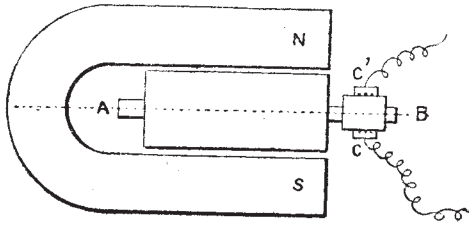

FIG. 2.

shaped steel magnet. The advantage of this arrangement is that the position of the armature utilises the whole field of force which lies between the limbs of the magnet. A large number of these little motors were set up by M. Marcel Deprez at different points of the galleries of the late Paris Exhibition in illustration of the possibility of distributing power from a central source. Two other forms of motor have more recently claimed attention. The first of these is the invention of M. Trouvé, and differs from that of M. Marcel Deprez in having an electromagnet instead of a permanent steel magnet to produce the field of magnetic force within which the armature is placed. The armature is also longitudinal and of the Siemens' type, with a slight modification, suggested by M. Trouvé, with the purpose of getting a more continuous action.

Fig. 3 shows how such a little motor may be attached

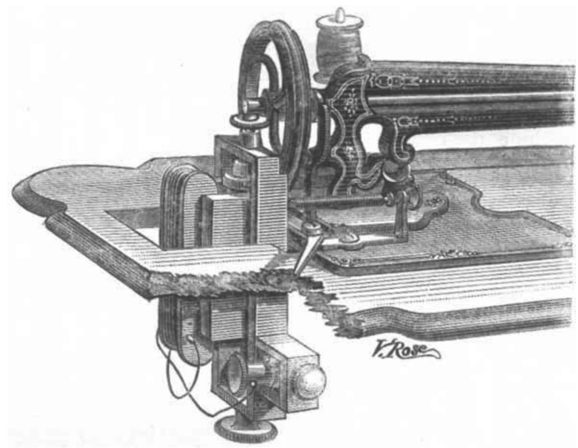

FIG. 3.

to a sewing machine. The axis of the armature is here vertical and carries a small disk or wheel of india-rubber which, when the motor is clamped in position, presses against the driving wheel of the sewing machine with a contact sufficient to enable it to drive the machine; a

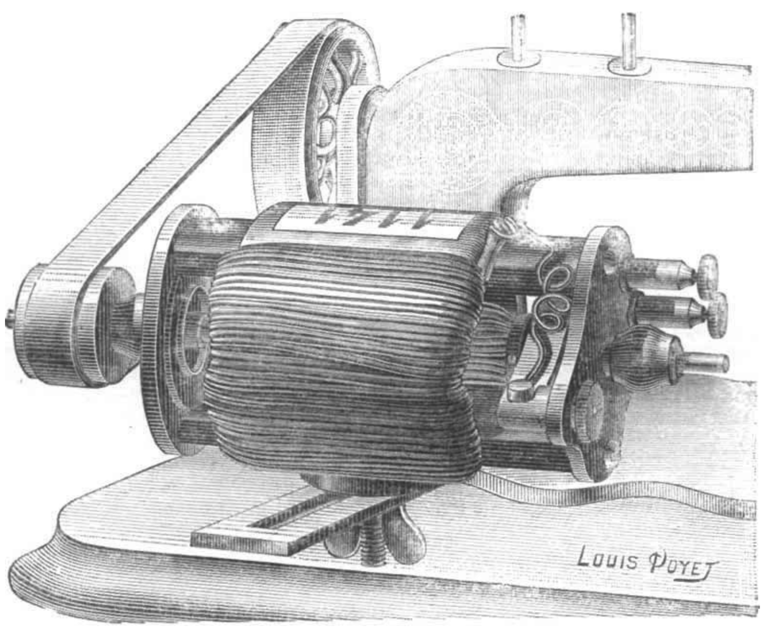

FIG. 4.

work which in spite of the small dimensions of the motor it accomplishes readily, on account of the high speed with which it runs. No steam-engine so small could possibly do the work without great loss, since steam will not give up its heat at an indefinitely great rate. It is said that three of Faure's accumulators weighing 50 lbs. each may, when fully charged, drive a sewing machine by a Trouvé motor for a whole week, working five or six hours every day. Motors similar to this have been fixed by M. Trouvé in his little electric canoe, and are suggested by M. Tissandier for balloon steering.

The favourite motor, however, at the present time appears to be that of Griscom, an American electrician, whose English agent is Mr. Paterson of Little Britain, and which we depict in Fig. 4. This elegant little machine is only 4½ inches long, and weighs a little over two pounds only. But it is remarkably powerful and steady in its action. It can, when fed with a current of

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requisite strength, rotate at a speed of 500 revolutions a minute. and in that time will do from 22 to 29 foot pounds of work. The construction is extremely simple. There is a Siemens' armature on a horizontal axis, within, and entirely surrounded by, the fixed electromagnet which not only serves to produce a powerful magnetic field, but also acts as a rigid framework for the rotating parts, which is thus protected from injury. The contact of the wires of the circuit with the commutator is made by two springs with little metallic friction-rollers at the end. The ironwork is made of malleable cast-iron, and so combines the advantage of high magnetic power and of cheap production. Mr. Griscom, the inventor, styles his little machine the double-induction motor on account of the reaction between the currents in the armature and those which supply the outer field-magnets. The inventor originally intended his motor to be used with a 6-cell bichromate battery, and he claims that one single charge of acid liquid will last long enough to enable a sewing-machine fixed to a motor to accomplish from 500 to 1000 yards of stitching. But there is no doubt that the motors work equally well with currents supplied from any other source in adequate strength. A gold medal was awarded at the late Paris Exhibition to Mr. Griscom for the excellence of his capital little machine.

It will be remarked that in each of the little modern motors described a simple Siemens' armature is employed in preference to one in the form of the Gramme ring or other complicated pattern. This is simply a consequence of the difficulty of constructing these more complex kinds of armature cheaply on a small scale. If they could be as cheaply constructed they would doubtless be preferable as having no dead points, and therefore not being liable to stick at starting, though this rarely happens with these little electric engines. It will also be noted that the last two forms are dynamo-electric instead of magneto-electric; that is to say their fixed magnets are electro-magnets of iron, not permanent magnets of steel. This is in order to gain space; for an electromagnet may be made far more powerful than a steel magnet of equal size, and therefore for an equal power the electromagnet will be of less bulk than the magnet of hard steel.

A CHAPTER IN THE HISTORY OF CONIFERÆ

The Podocarpeæ

THE tribe is limited to three genera. Nothing is known as to the ancestry of two of these—*Microcachrys* and *Saxegothea*, represented now by a single species each; but the third, *Podocarpus*, comprises fifty-nine species according to Gordon.[1] The fruits are drupaceous or nut-like, and the seed generally possesses a hard shell and contains a dicotyledonous embryo. The leaves are either distichous, like the yew, or imbricated, and vary from very small to several inches in length; and although generally parallel-nerved, two species in the Kew Herbarium have distinctly dicotyledonous venation. Like the rest of the Coniferæ, some species form colossal trees, exceeding 200 feet in height. They are classified in the "Genera Plantarum" into four groups—*Nageia*, which contains the only Conifer indigenous to the East Indies; *Eupodocarpus*, comprising the vast majority of the species; *Stachycarpus*, and *Dacrycarpus*. The two latter sections are represented in the Eocene, and are at present limited to the Malay Archipelago, Australia, New Zealand, and South America. Notwithstanding their immense distribution and the evidence of vast antiquity which the genus presents, scarcely anything is known of their past history. In most cases the foliage when detached has little to distinguish it from better-known Coniferæ, and the fruits, in the fossil condition, seldom present anything by which their gymnospermous origin can be inferred. Except a doubtful and undescribed species from Aix-la-Chapelle, no podocarp is known of earlier age than Eocene, and they disappear from temperate Europe with the Oligocene. Like the Araucaria and other genera innumerable, they seem to oppose the theory that all plants have originated in northern regions, and passed south by way of existing continents; and unless it is supposed that their present distribution was accomplished prior to the Cretaceous, we are forced to admit, in order to explain their presence in Chili and other parts of South America, a land connection far to the south of that admitted by Wallace and those who share his opinions. No trace of podocarp has in fact been made known either from the Arctic or the American Cretaceous and Tertiary floras.

[1] Sir Joseph Hooker believes they may eventually be reduced to less than orty, since several are very imperfectly known.

The fossil Podocarps that are known may be conveniently classified under two heads—those that have shed their leaves separately, and those that have shed them adhering to branchlets.

Of the former, various species have been described by Saporta, Heer, Unger, Ettingshausen, and others, ranging in time from the Suessonian to the lowest stage of the Aquitanian. They therefore form a group in Central Europe essentially characteristic of the Eocene, and are quite unknown in the Miocene, except in Italy. They occur at Aix, Lat. 43°, and extend up to about Lat. 48°, which represents their Eocene distribution as at present published. It may therefore emphasise the importance attaching to a proper examination of our British Eocene floras, when I state that they have now been found not only at Bournemouth, but in Antrim and in Mull, or as far north as about 56½°. The British species differs from all those previously figured, for it has a broadly sessile and articulated base, whilst the others are represented as tapering to a fine point. The leaves, though scarcely 2 mm. broad, sometimes reach 5 inches in length. Those from Mull, and, as far as can be seen, the half-leaf from Antrim, are specifically identical with the Bournemouth form, and this is the more remarkable since the latter is confined to the uppermost bed under the Coastguard Station, and has never been found in any of the other numerous beds from which I have so largely collected. Of the Continental species, the nearest to it are mostly from Aix, whose flora in several other respects presents the greatest affinities with ours. Besides the identity in appearance of some of the leaves with many existing Podocarps, as *P. andina*, the microscopic structure of the leaves and wood peculiar to them was recognised and explained by Unger. I have not seen any records of the fruits being found, and although some from Bournemouth might belong to the species, no essential character is preserved.

Of the Podocarps whose leaves are shed attached to branchlets, only the most insignificant traces have been hitherto known. I have now to add at least two species whose foliage, fruit, and flowers are preserved.

The first and most ancient is from Alum Bay, and has hitherto been supposed a Sequoia, a Taxus, a Cypress, &c., by distinguished Continental professors who have examined it. Possessing polymorphic foliage, it falls into the "Dacrycarpus" division of Hooker. By far the larger proportion of the foliage collected is distichous, being much smaller than that of the yew, with the bases of the leaves prolonged down and adhering to the stem, and with three out of the five rows, though still recognisable, reduced to small dimensions. This abortion of some of the leaves, in order to permit the remainder to expand into two lateral rows, is exceedingly characteristic of ancient Coniferæ, and still survives in Sequoia, being probably the precursor of the truly distichous arrangement seen in Taxus, Taxodium, Toveya, and other existing Conifers. The fruit is small, petiolated, and remarkable as occurring on the distichous branches. The fossils of Alum Bay were, unfortunately, collected principally for sale, and the unattractive imbricated branchlets and the insignificant-looking fruit were doubt-

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